Past and Present Energy Societies

How Energy Connects Politics, Technologies and Cultures

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An Introduction

"Where were you when the lights went out?" With this short, pointed question, David Nye opened his book on the history of electricity blackouts in America.[1] These few words sufficed to set his program, namely to explore blackouts not as technical failures but social constructions. Thus, he used sudden darkness to illuminate the political, technological and cultural dynamics of high-energy societies.

In the studies that follow, we are pursuing a similar aim but with a different angle. To investigate how energy concatenates politics, technologies and cultures, we invited researchers from different fields in the humanities and social sciences to discuss energy as a resource, a symbol and a consumer good.[2] We focussed attention on a variety of sites in Europe and the United States and travelled not just through space but also through time – from the 19th to the 21st century – in order to understand how energy was perceived, appropriated and put to use for a broad variety

1 | David E. Nye: *When the Lights Went Out. A History of Blackouts in America.* Cambridge, MA: MIT Press 2010, 1.

2 | The contributions in this volume are based on papers given at the international workshop "Deified – Damned – Depleted: Energy as Symbol, Resource and Consumer Good", organized by the research project "Objects of Energy Consumption" at the Deutsches Museum, January 20-22, 2011. We thank the Federal Ministry of Education and Research (BMBF) for the generous funding of the research project, the workshop and this publication.

of purposes. Presenting here the findings from these studies, we hope to contribute new perspectives on past and present energy societies.

At the outset, however, such an undertaking encounters a major difficulty. This is the problem of finding a comprehensive and definitive concept of energy, not just in the sciences but in technology and culture. In science, the physicist and Nobel laureate Richard Feynman once stated in one of his famous lectures in the 1960s: "It is important to realize that in physics today, we have no knowledge of what energy is. We do not have a picture that energy comes in little blobs of a definite amount."[3] There are, of course, formulas to calculate a numerical quantity that is always constant. But according to Feynman, this numerical quantity is an abstract thing that tells us nothing about the mechanisms and reasons for the different formulas.[4] Other scholars from a broad spectrum of fields – including more Nobel laureates – advanced the idea of energy as an all-encompassing concept. This becomes obvious in the introduction of physicist R. Bruce Lindsay's history on the concept of energy: "No other concept [than the idea of energy, K.C.Z.] has so unified our understanding of experience. Without exaggeration we can say that every single aspect of human experience, whether it be what we observe in the external world, or what we do or what is done to us, can be adequately described either as a transfer of energy in one form from one place to another or the transformation of energy from one form to another."[5] But also Lindsay ends up asking: "But what is the thing that is transferred and transformed?" He consulted encyclopaedias and dictionaries but to no result. Fighting resignation, he asked: "Must you then pursue a whole course of university physics with its awful array of mathematical symbolism in order to understand what energy means, how it is measured, and the reason for its overwhelmingly important role in human life?"[6] Lindsay suggests instead trying another approach, namely to detect the key idea in energy. Thus, from a philosophical perspective he

3 | Richard P. Feynman, Robert B. Leighton, Matthew Sands: *Feynman Lectures on Physics: Mainly Mechanics, Radiation, and Heat*. 3 vols. Reading, MA: Addison-Wesley, 1966, 59.

4 | Feynman: *Feynman Lectures on Physics*, 59.

5 | R. Bruce Lindsay: *Energy. Historical Development of the Concept*. Stroudsburg, PA: Dowden, Hutchinson & Ross, 1975, 2.

6 | Lindsay: *Energy*, 5.

characterized energy as "constancy in the midst of change."[7] This short assertion effectively translates the first law of thermodynamics (that energy is 'conserved') into a philosophical statement that is broad enough to guide Lindsay's exploration on how energy emerged as a concept in history.

Scholars and intellectuals in the social sciences, however, differ from physicists because they are not so much interested in exploring what is constant but rather in seeking explanations of change. In doing so, well-known academics contributed to what has become known as the 'energy-civilization equation', i.e. a train of thought that deduced societal achievements (civilization) from increases in energy consumption.[8] "Because we use a hundred and ten times as much coal as our ancestors, we believe ourselves a hundred and ten times better, intellectually, morally, and spiritually."[9] This is how Aldous Huxley, author of the dystopian novel *Brave New World* (1932), satirically presented the energy-civilization equation that many other writers and thinkers assumed was a valid construct. Radical innovations, such as the steam engine, the internal combustion engine, and the dynamoelectric machine, fundamentally changed existing energy regimes and led to the development of thermodynamics, the basic formulation of the relationship between work and energy in Newtonian physics, and the establishment of the first and second laws. Together, they also inspired scholars to define energy as the driving force throughout human history that is responsible for all changes.

That energy might fundamentally drive history is the central premise of this introduction. As a first step, it will outline, albeit briefly, how the deterministic tradition of a societal energetics emerged and changed against the background of energy transitions and societal evolutions. Contextualizing and historically grounding the developing energy-civilization equation will, it is hoped, provide us with the means to understand that the challenges of the pending energy transitions of the 21st century require a more reflective picture on the complex relationship between energy and society. This introduction then goes on to introduce

7 | Lindsay: *Energy*, 5.

8 | For an overview see George Basalla: "Energy and Civilization", in: Chauncey Starr/Philip C. Ritterbush, eds. *Science, Technology, and the Human Prospect: Proceedings of the Edison Centennial Symposium*. New York: Pergamon Press, 1980, 39-52.

9 | Aldous Huxley: "Progress", in: *Vanity Fair* 29 (1928), 69.

the anthology's chapters and to show how the authors approach past and present energy societies and thus contribute new perspectives on the linkages between energy, politics, technologies and cultures.

REVISITING THE ENERGY-CIVILIZATION EQUATION

Many writers in 19th century Great Britain attributed the country's becoming 'the workshop of the world' and the then wealthiest nation to the advent and expansion of steam power.[10] The technical and popular literature on the European continent replicated this deterministic energy-civilization view in many versions. But early on we can also find a critical stance against this formulation. Although his statement, "The hand-mill gives you society with the feudal lord; the steam-mill society with the industrial capitalist," is often interpreted as proof for the assumption that Karl Marx (1818-1883) subscribed to the energy-civilization equation[11], Marx explicitly contradicted this view in the chapter on machinery and big industry in the first volume of *Capital*.[12] Here he maintained that not the steam engine bore the responsibility for the industrial revolution but rather the machine tool. "The machine proper is therefore a mechanism that, after being set in motion, performs with its tools the same operations that were formerly done by the workman with similar tools. Whether the motive power is derived from man, or from some other machine, makes no difference in this respect."[13] Others, however, were more impressed by the power of steam and subsequent heat engines.

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10 | For details cf. Basalla: "Energy and Civilization", 42-43.

11 | Karl Marx: *The Poverty of Philosophy. Chapter 2, Second Observation*, http://www.marxists.org/archive/marx/works/1847/poverty-philosophy/ch02.htm, Accessed 28.12.2011.

12 | In the online edition, the chapter on "Machinery and Modern Industry" is chapter 15. Cf. Karl Marx: *Capital. A Critique of Political Economy, Volume One*. Chapter 15: Machinery and Modern Industry. Section 1 – The Development of Machinery. http://www.marxists.org/archive/marx/works/1867-c1/ch15.htm, Accessed 28.12.2011.

13 | Shortly thereafter Marx stated again: "The machine, which is the starting-point of the industrial revolution, supersedes the workman, who handles a single tool, by a mechanism operating with a number of similar tools, and set in motion

The British philosopher and sociologist Herbert Spencer (1820-1903) subscribed to the energy-civilization equation when he reasoned that energy is largely responsible for material differences between societies.[14] The more energy a society could harness from its resources, the better it fared relative to others. Based on his notion of physical power, Spencer conceived society as an energetic system. He interchangeably used metaphors of power, energy and force for developing his concept of societal evolution. Surprisingly, however, Spencer did not deal with the social use of non-human energy forms.[15] That remained for Sir Patrick Geddes (1854-1932) who built on Spencer but advanced the use of non-human energy to become a main argument for explaining societal evolution. A Scottish biologist, sociologist, and city planner who co-founded the British Sociological Society in 1902 and strove to develop a concrete and applied sociology of cities that he called "civics", Geddes subdivided the industrial era into a 'paleotechnic' and a 'neotechnic' phase. He distinguished 'paleotechnics', "a comparatively crude and wasteful technic age, characterised by coal, steam, and cheap machine products, and a corresponding quantitative ideal of 'progress of wealth and population'" from 'neotechnics', "a finer civilisation, characterised by the wider command, yet greater economy of natural energies, by the predominance of electricity, and by increasing victory of an ideal of qualitative progress, expressed in terms of skill and art, of hygiene and education, of social polity, etc."[16] Geddes shared his admiration of electricity as an agent of societal betterment with many others. But his specific, energy-based framework of societal as civic evolution would find just one important intellectual heir, whom I will introduce later.

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by a single motive power, whatever the form of that power may be." Marx: *Capital*, Section 1 – The Development of Machinery.

14 | Herbert Spencer: *First Principles*. New York: A. L. Burt, 1880.

15 | Cf. Andrew M. McKinnon: "Energy and Society: Herbert Spencer's 'Energetic Sociology' of Social Evolution and Beyond", in: *Journal of Classical Sociology* 10:4 (2010), 439-55.

16 | Patrick Geddes: "Civics: As Concrete and Applied Sociology, Part II", in: *Sociological Papers* 2 (1906), 58-119, available at http://www.gutenberg.org/files/13205/13205-h/13205-h.htm, Accessed 28.12.2011. See also Patrick Geddes: *Cities in Evolution: An Introduction to the Town Planning Movement and the Study of Civics*. London: Williams & Norgate, 1915, Chaper IV.

Similar to Geddes but framed in terms of a cultural theory, his German contemporary, the chemist and Nobel laureate Wilhelm Ostwald (1853-1932) established energy as the core concept of his world view. Ostwald argued that the transformation of crude energy (*rohe Energie*) into useful energy (*Nutzenergie*) was at the base of all social change.[17] According to Ostwald, the efficiency of this transformation (*Güteverhältnis*) determines the amount of free energy that societies can put to use for cultural work. This then would be the second principle of energetics. While the first principle is the first law of thermodynamics (i.e. conservation of energy), the second principle serves as a guideline of cultural development.[18] Ostwald concluded his energy-deterministic worldview with the firm appeal, "Do not waste energy!" which he ambitiously called the energetic imperative.[19] Ostwald's reasoning on the role of energy in society provoked criticism from, among others, Max Weber, who accused Ostwald of deriving value judgements from hard science and thus adhering to a naturalism that does not foster but prohibit a fruitful discussion between the hard and the cultural sciences.[20]

But Ostwald inspired other thinkers to expand on his ideas of energetics. One of them was the U.S. American historian and writer Henry Adams (1838-1918), who expanded his notion of energy beyond the concept of physics. In his famous 1900 essay "The Dynamo and the Virgin", Adams developed a multi-stage theory of Western civilization that was based on energy. He differentiated four stages of increasingly shorter length, what he saw as proof of a historical process of acceleration. The first stage was driven by religious energy embodied in the Virgin Mary. This stage lasted until around 1600. The next stage was marked by the coming of the steam engine and led into the age of mechanical energy that lasted for the next 300 years. In 1900, symbolized by the spectacle of the dynamoelectric machine, the age of electricity supplanted the mechanical stage, but it lasted only 17 and a half years. By 1917, the ether that filled the whole

17 | Wilhelm Ostwald: *Energetische Grundlagen der Kulturwissenschaft*. Leipzig: Klinkhardt, 1909, 24.

18 | Ostwald: *Energetische Grundlagen*, 39.

19 | Wilhelm Ostwald: *Der energetische Imperativ.* Leipzig: Akademische Verlags-Gesellschaft, 1912.

20 | Max Weber: "Energetische Kulturtheorien", in: *Gesammelte Aufsätze zur Wissenschaftslehre.* Tübingen: Mohr, 1968, 400-26.

universe would emerge as the only still available source of energy, but the emergent ethereal civilization was doomed to perish by 1921. Assuming that the universe relied on a fixed supply of energy, Adams expected an apocalyptical end of history due to the law of entropy.[21]

At the same time as Adams published his dystopian visions, other scholars also warned of the limited availability of usable energy stemming from the second law of thermodynamics. The British chemist and Nobel laureate Frederick Soddy (1877-1956) was among them. In his 1912 book *Matter and Energy*, Soddy stated that the "laws expressing the relations between energy and matter are not solely of importance in pure science, [but] they [also] necessarily come first in order [...] in the whole record of human experience, and they control, in the last resort, the rise and fall of political systems, the freedom or bondage of nations, the movements of commerce and industry, the origin of wealth and poverty, and the general physical welfare of the race."[22] As a pioneer in the study of the atom, however, Soddy turned from pessimist into an anxious protagonist of atomic energy. Releasing the energy in the heart of the atom would allow humankind to escape the danger inherent in the scarcity of coal (and oil) and instead bring about an affluent paradise of the atomic future.[23] Thus, roughly three decades prior to the euphoric though sometimes ambivalent assessment of the atom during the Cold War, Soddy preached on the promise of abundance that would be based on atomic energy. He also pondered the possibility of producing atomic weapons. Similarly, science fiction writer H. G. Wells foresaw the danger of atomic warfare and developed the vision that humankind would be able to use the atom peacefully only after having gone through a devastating atomic war. Wells dedicated his novel, written

21 | Henry Adams: *The Education of Henry Adams*. Boston: Houghton Mifflin, 1961, chapters 25 and 33, quoted in David Nye: *Electrifying America. Social Meanings of a New Technology, 1880-1940*. Cambridge, MA: MIT Press 1997, 143.

22 | Frederick Soddy: *Matter and Energy*. London: Williams and Norgate, 1912, 10-11, quoted by Leslie A. White: *The Evolution of Culture: The Development of Civilization to the Fall of Rome*. New York: McGraw-Hill, 1959, 39.

23 | Frederick Soddy: *Science and Life*. New York: E. P. Dutton, 1920, 22-24; Frederick Soddy: *Wealth, Virtual Wealth and Debt*. London: George Allen and Unwin, 1926, 49-68.

before the beginning of World War I, to none other than Frederick Soddy.[24] The chemist Soddy saw a second impediment to the arrival of his atomic 'Garden Eden'. This was the prevailing economic system. Therefore, he turned to economics and called for a major change in the economic system that would be based on the laws of thermodynamics.[25]

While Soddy derived his optimism for the future of humankind from his faith in the still-to-be-tapped mighty atom, many of his contemporaries in the first third of the 20th century focussed their hopes for a better future on electricity as a clean form of energy. Scientists, engineers, intellectuals, entrepreneurs, feminists, politicians – in short, representatives of all strata of society from many countries – expected to better society via electrification.[26] One of them was Vladimir Ilyich Lenin, leader of the communist revolution in Russia, who pushed electrification because he believed that the power of Soviets plus electrification would lead toward true communism.[27] British feminists cherished quite comparable hopes when they formed an Electrical Association for Women as a step toward their emancipation.[28] In the United States during the Great Depression, leaders of the New Deal and their followers championed the electrification of the Tennessee Valley as a means to bring the backward South into the 20th century.[29] Even before the turn of the century in Germany, representatives of the conservative as well as the socialist political camp connected their societal visions to the availability of electricity, not just as a power source but as a source for empowerment of their respective clienteles. Socio-conservative economists as well as engineers hoped to secure the survival

24 | Basalla: "Energy and Civilization", 47.

25 | Soddy: *Wealth, Virtual Wealth and Debt*, 49-68.

26 | For an early review of this literature, see James W. Carey and John J. Quirck: "The Mythos of the Electronic Revolution", in: *The American Scholar*, Parts I and II, 39 (1970), 219-41, 395-424.

27 | On Lenin and Soviet electrification, see Jonathan Coopersmith: *The Electrification of Russia, 1880-1926*. Ithaca, NY: Cornell University Press, 1992.

28 | Carroll W. Pursell, Jr.: "Domesticating Modernity: The Electrical Association for Women, 1924-1986", in: *British Journal for the History of Science* 32:1 (1999), 47-67.

29 | Thomas P. Hughes: *American Genesis*: *A Century of Invention and Technological Enthusiasm.* New York: Viking, 1989, 353-81; Nye: *Electrifying America*, 304-35.

of small-scale industries and traditional crafts against the competition of big industry by introducing small-scale electrical engines as power source.[30] At the same time, the socialist leader August Bebel (1840-1913) extended and republished his socialist utopia under the title, *The Woman and Socialism*, in several editions. Therein, he envisioned the electrification of the household as the precondition for the emancipation of women, and he described his socialist utopia in terms of an electrified paradise.[31]

German engineers also felt empowered as innovators in the field of electric power generation, its transmission, and its use to minimize the effects of entropy, thus following Ostwald's energetic imperative.[32] The engineers called for superseding the principle of profitability by the principle of efficiency, as the latter was the most important regulator of the

30 | Ulrich Wengenroth: "Motoren für den Kleinbetrieb. Soziale Utopien, technische Entwicklung und Absatzstrategien bei der Motorisierung des Kleingewerbes im Kaiserreich", in: Ulrich Wengenroth, ed. *Prekäre Selbstbestimmung. Zur Standortbestimmung von Handwerk, Hausindustrie und Kleingewerbe im Industrialisierungsprozess*. Stuttgart: Steiner, 1989, 177-205. In the U.S., ironically, Henry Ford became a champion of decentralized "village industries" even though his company's Highland Park and River Rouge factories epitomized the very essence of mass production. See Howard Segal: *Recasting the Machine Age: Henry Ford's Village Industries*. Amherst: University of Massachusetts Press, 2005. The German inventor Rudolph Diesel strongly believed that his new engine possessed all the right characteristics to decentralize factory motive power, thereby mitigating many of the negative aspects of the factory system, which he believed could be attributed to the steam engine and its centralized power distribution system (belts, pulleys, and line shafting that conveyed power to manufacturing processes, machine tools, textile machinery, and the like from a central source). See Diesel's discussion in his *Diesel's Rational Heat Motor: A Lecture*. New York: Progressive Publishing Company, 1897, 18.

31 | August Bebel: *Die Frau und der Sozialismus*. 37th ed. Stuttgart: Dietz, 1904.

32 | Hans Dieter Hellige: "Wirtschafts-, Energie- und Stoffkreisläufe in säkularer Perspektive: Von der thermodynamischen Entzauberung der Welt zur recyclingorientierten Wachstumsgesellschaft", in: Gangolf Hübinger/Ernst Schulin, eds. *Universalgeschichte und Nationalgeschichten*. Freiburg im Breisgau: Rombach, 1994, 291-315.

economy.[33] In comparison to the economist, the engineer would act as the superior housekeeper as he calculated efficiencies based on the inputs and outputs of energy in his works.[34] This would entitle engineers to be the leaders of society because only they knew best how to govern the economy and society in the most efficient way.[35]

Similar ideas also sprang up in the United States. In 1921, social scientist Thorstein Veblen (1857-1929) proposed a Soviet of Technicians, which would be more competent in managing the country's industrial system than what he termed Vested Interests and their absentee owners.[36] Rather than the wasteful, highly inefficient management of industry by the financial agents of absentee owners, the Soviet of Technicians would responsibly govern the allocation of energy sources, equipment, materials, and manpower. Led by the self-trained and self-styled 'Bohemian engineer' Howard Scott, subscribers to Veblen's *Engineers and the Price System* soon envisaged a new currency to replace money, a currency based on energy instead of gold. Although the Veblen-inspired movement flowered only briefly as "Technocracy, Incorporated", energy-based technocratic thought endured in many forms, including the ideas implicit in one-time Technocracy, Inc. member M. King Hubbert (of 'Hubbert's Peak' or

33 | The most explicit conclusion drew Rathenau and Moellendorff when they required reforming the post WWI economy according to the principles of the warfare state into a social economy where the market was replaced by organization for the sake of efficiency. Cf. Karin Zachmann: "Wirkungsgrad contra Wertgrad: Zur Entstehung des Konflikts zwischen der technischen und der ökonomischen Auffassung vom Wirtschaften", in: *Technikgeschichte* 62:2 (1995): 103-31.

34 | Julius Schenk: *Die Begriffe Wirtschaft und Technik und ihre Bedeutung für die Ingenieurausbildung.* Breslau: Preuss & Jünger, 1913.

35 | On the engineers' claim to societal leadership after WWI see Charles Maier: "Zwischen Taylorismus und Technokratie: Gesellschaftspolitik im Zeichen industrieller Rationalität in den zwanziger Jahren in Europa", in: Michael Stürmer, ed. *Die Weimarer Republik. Belagerte Civitas.* Königstein: Athenäum, 1985, 188-213; Karin Zachmann: *Mobilisierung der Frauen. Technik, Geschlecht und Kalter Krieg in der DDR.* Frankfurt/Main: Campus, 2004, 136-49.

36 | Thorstein Veblen: *The Engineers and the Price System.* Kitchener, ON: Batoche Books, 2001 [1921], available at http://socserv.mcmaster.ca/econ/ugcm/3ll3/veblen/Engineers.pdf, Accessed 28.12.2011.

'peak oil' fame) and the historical framework put forward in 1934 by the American 'public intellectual' Lewis Mumford (1895-1990).[37]

In the early 1930s, Mumford subscribed to Veblen's diagnosis and critique of an increasing "dissociation between capitalism and technics."[38] In his widely-read fundamental work *Technics and Civilization*, published in 1934, Mumford explored the development of the technology-driven Western civilization. By expanding the framework of Geddes, whom he praised as his master, Mumford differentiated three historical epochs that had formed technologically distinct complexes. A determining factor for each epoch was energy. The ecotechnic phase was dominated by water power and wood energy sources. The paleotechnic phase was characterized by a coal-based energy system. The neotechnic phase, eventually, rested upon the modern electricity-based energy complex. Mumford analyzed the social effects of new power sources and technologies in great detail and he shared his contemporaries' overly enthusiastic vision of the social effects of electricity.[39]

The advent of atomic power and its ambivalent perception as both cornucopia and sword of Damocles in the fiercely contested Cold War

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37 | On the technocracy movement, see Daniel Bell: *The End of Ideology.* New York: The Free Press, 1960; Edwin T. Layton, Jr.: *Revolt of the Engineers.* Cleveland, OH: Case Western Reserve University Press, 1971; Henry Elsner, Jr.: *The Technocrats: Prophets of Automation.* Syracuse, NY: Syracuse University Press, 1967; William E. Akin: *Technocracy and the American Dream: The Technocrat Movement, 1900-1941.* Berkeley: University of California Press, 1977; and Howard Scott's own, infamous "Hotel Pierre" address of January 1933, "Technocracy," available online at http://www.technocracy.org/technical-alliancetn/howard-scott/208-societyscott, Accessed 28.12.2011. On Hubbert, see Ronald Doel's biographical sketch in the *Handbook of Texas Online*, http://www.oilcrisis.com/hubbert/bio_doel.htm, Accessed 28.12.2011. On the American and the German technocracy movement in comparison see Stefan Willeke: *Die Technokratiebewegung in Nordamerika und Deutschland zwischen den Weltkriegen.* Frankfurt/Main: Lang, 1995.

38 | Lewis Mumford: *Technics and Civilization*. New York: Harcourt, 1934, 366.

39 | Near the end of *Technics and Civilization*, albeit briefly, Mumford even projected a future "biotechnic" phase that some analysts have seen as Mumford's vision of a more sustainable socio-technic energy regime. Mumford: *Technics and Civilization*, 353.

nourished new thinking about the energy-civilization equation. The American anthropologist Leslie A. White (1900-1975) initiated this renewed discussion in the midst of World War II with the publication of his influential article "Energy and the Evolution of Culture" in *The American Anthropologist*. Leslie asserted that anthropology was a "branch of natural science which deals with matter-and-motion, i.e. energy, phenomena in cultural form, as biology deals with them in cellular, and physics in atomic form."[40] White established himself as an evolutionist against the anthropological school of Franz Boas by tying cultural evolution to human control of energy. Cultural evolution was to be measured by the amount of energy the culture in question was able to harness. As White explicitly stated: "The key to the future, in any event, lies in the energy situation. [...] Should [...] the amount of energy that we are able to harness diminish materially, then culture would cease to advance or even recede."[41] That the great civilizations of China, India, Egypt, the Near East, Central America, and Peru had failed to advance after a phase of rapid development, White attributed to their limitations in the availability of energy. With respect to the future, he was optimistic, as he counted on tapping of new sources of energy, including atomic energy, which he saw as the most intriguing possibility.[42] If the technology of nuclear fission succeeded, the energy resources would be multiplied a thousand fold. Even if nuclear energy were to fail, White's optimism remained steadfast because, he underscored, "there is always the sun." He expected that the sun could become the direct and thus chief source of power in the future.[43] In 1959, with civilian nuclear energy – i.e. 'the Peaceful Atom' – well on its way toward realization, White extended his 1943 cultural energetics framework into a book-length exploration of the evolution of culture to the fall of Rome. He meant the book to be the first of a three-volume project examining the evolution of cultures over all historical epochs. That energy was the main variable in his explanatory framework becomes especially clear from the announced

40 | Leslie A. White: "Energy and the Evolution of Culture", in: *American Anthropologist* 43:3 (1943), 335.

41 | White: "Energy and the Evolution of Culture", 350.

42 | White: "Energy and the Evolution of Culture", 350.

43 | White: "Energy and the Evolution of Culture", 351.

content of his planned second book, tentatively titled "The Fuel Revolution and Its Institutional Concomitants."[44]

Four years before Leslie White published *The Evolution of Culture*, the American sociologist Frederick W. Cottrell (1903-1979) put another version of the energy-civilization equation on the book market, *Energy and Society. The Relation between Energy, Social Change, and Economic Development* (1955). In the midst of the intense competition between two political, economic, and social systems that constituted the Cold War, Cottrell aimed at discovering "the relations between the energy converters and fuel men use and the kinds of society they build."[45] This could help to evaluate the competing systems' claims on the betterment of humankind, as the possibilities of change would not only rest on human beings' values but also on knowledge of their physical potentialities. Cottrell stated that energy was the key to determine – or unlock – these potentialities: "It is that the energy available to man limits what he can do and influences what he will do."[46] Departing from this thesis, he differentiated 'low-energy societies' from 'high-energy societies' and explored in great detail societal changes that followed from the transition to high-energy converters. His book, however, was not well received and was unfavourably reviewed by anthropologists, especially the followers of Leslie A. White. Marshall Sahlins, a former student and then colleague of White, accused Cottrell of an inadequate theory of cultural change, as Cottrell put values at the centre of his explanation of cultural change but at the same time let cultural change determine values. This not only prevented energy determinism but also prohibited "a satisfactory explanation of the origins of energy-based changes."[47] Cottrell himself came to the same conclusion, as he wrote, "perhaps the contribution of this essay lies chiefly in the fact that it suggests whole areas of ignorance whose exploration might increase the accuracy of thinking about the future development of human society."[48] However, Cottrell's framework of

44 | White: *The Evolution of Culture*, x.

45 | Frederick W. Cottrell: *Energy and Society: The Relation between Energy, Social Changes, and Economic Development*. New York: McGraw-Hill, 1955, 3.

46 | Cottrell: *Energy and Society*, 2.

47 | Marshall D. Sahlins: "Energy and Society: The Relation between Energy, Social Change, and Economic Development. W. Frederick Cottrell", in: *American Anthropologist* 58:6 (1956), 1143.

48 | Cottrell: *Energy and Society*, 311.

thinking in terms of a low-energy and a high-energy society based on the energy converters and the fuels that had been used proved to be a useful concept to several engineer-historians in the United States and was taken up by subsequent researchers such as Vaclav Smil.

The energy crisis of the 1970s brought to the fore a more critical perspective on the energy-civilization equation. The Romanian-born U.S. economist Nicholas Georgescu-Roegen (1906-1994) published *The Entropy Law and Economic Process* in 1971 where he criticized the mainstream economists for not recognizing the entropy law with its consequences for economic growth.[49] In his book, Georgescu-Roegen laid the groundwork for the concept of a steady-state-economy that was further developed by his student Herman Daly. The latter defined such an economy as "an economy with constant stocks of people and artefacts, maintained at some desired, sufficient levels by low rates of maintenance 'throughput', that is, by the lowest feasible flows of matter and energy from the first stage of production to the last stage of consumption."[50] The idea of a steady state can be traced further back in history. Daly referred extensively to the 19th century British economist John Stuart Mill to gain credit for Georgescu-Roegen's and his concept. Its prominence in the late 1970s, however, emerged from the coincidence of the environmental movement with the energy crisis.[51]

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49 | Nicholas Georgescu-Roegen: *The Entropy Law and Economic Process*. Cambridge, MA: Harvard University Press, 1971.

50 | Herman E. Daly: *Steady-State Economics*. San Francisco: Freeman, 1977, 17.

51 | Not only would the work of Herman Daly build on and advance Georgescu-Roegen's fundamental ideas, but so would the scholarship of Kozo Mayumi. See Kozo Mayumi: *The Origins of Ecological Economics: The Bioeconomics of Georgescu-Roegen*. London: Routledge, 2001. To a large extent, the more vocal, non-scholarly publications of Jeremy Rifkin rely on Georgescu-Roegen's work. Cf. e.g. Jeremy Rifkin: *Entropy. A New World View*. New York: The Viking Press, 1980 or more recently Jeremy Rifkin: *The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World*. London: Palgrave Macmillan, 2011. On the history of the energy crisis of the 1970s, see Karen R. Merrill: *The Oil Crisis of 1973-1974: A Brief History with Documents*. Boston: Bedford/St. Martin's, 2007 and Jens Hohensee: *Der erste Ölpreisschock 1973/74*. Stuttgart: Steiner, 1996. On the history of the ecological movement of the 1960s and

The no-growth concept gave the energy-civilization equation new meaning as it questioned the hitherto commonly held assumption that societal progress is bound to energy-fuelled economic growth. By contrast, anti-growth scenarios called for human-scaled and decentralized technological cultures that would reduce the dependency on high-energy converters. The American physicist Amory B. Lovins took the growth-critical ideas as point of departure for his program of "soft energy paths" that were to supersede the hitherto prevalent – and unsustainable – "hard energy path". As a passionate opponent of nuclear power, Lovins ardently criticized the "hard path" conclusion that the political and energy establishment had drawn from the crisis. Instead of pushing nuclear power and readily available fossil fuels – especially coal – to secure fuel supplies, Lovins called for an end-use-orientation that would determine "how much of what kind of energy is needed to do the task for which the energy is desired, and then supplying exactly that kind."[52] This reorientation from a source- and production-based toward an end-use based determination of energy needs was to work as a precondition for a direction change from the hard to the soft path of energy policy. The latter implied "a prompt and serious commitment to efficient use of energy, rapid development of renewable energy sources matched in scale and energy quality to end use needs, and special transition fossil fuel technologies."[53]

Lovins' program attracted enormous attention. While the physicist Lovins did not elaborate the social consequences of his soft-path proposition,

1970s, see Samuel Hayes: *Beauty, Health, and Permanence: Environmental Politics in the United States, 1955-1985.* Cambridge: Cambridge University Press, 1987; Karl Ditt: "Ursprünge und Anfänge der Umweltpolitik in der Bundesrepublik während der 1960er und frühen 1970er Jahre", in: Matthias Frese/Julia Paulus/Karl Teppe, eds. *Demokratisierung und gesellschaftlicher Aufbruch. Die 1960er Jahre als Wendezeit der Bundesrepublik.* Paderborn: Ferdinand Schönigh, 2003, 305-47; Jens Ivo Engels: *Naturpolitik in der Bundesrepublik. Ideenwelt und politische Verhaltensstile in Naturschutz und Umweltbewegung 1950-1980.* Paderborn: Ferdinand Schöningh, 2006.

52 | Amory B. Lovins: *Soft Energy Paths*. Cambridge, MA: Friends of the Earth and Ballinger Publishing Co, 1977, 8.

53 | Lovins: *Soft Energy Paths*, 25.

sociologists dealt with its implications for societal changes.[54] Thus, the soft-path-concept remained bound to the energy-civilization equation, as it expected to change society in fundamental ways by restructuring its energy provision and needs. While the energy establishment fiercely contested this vision, protagonists of the internationally strengthening environmental movement expanded it and developed new arguments for the urgency of the transition.[55] As early as 1981, the challenge of climate change was introduced as an additional argument for the transition to soft energy paths. The urgency and international character of soft-path proponents are evident in the 1981 book *Least-Cost Energy – Solving the CO_2-Problem* that Amory Lovins and his wife L. Hunter Lovins co-authored with their German colleagues Florentin Krause and Wilfrid Bach.[56] Krause was a co-founder of the German Eco-Institute in Freiburg and a co-author of an energy study that was published under the title *Energiewende* (energy turn) in 1980. This study argued that economic growth would not require more energy and that especially nuclear energy should be abandoned and the use of fossil fuels could be significantly curtailed.[57] Bach had headed the research center of applied climatology and environmental studies at the University of Münster since the mid-1970s and published widely on the relationship between energy use and climate change.[58]

The no-growth scenario that was developed by alternative economists and the soft-path concept that stemmed from scientists fuelled the energy debate in the decade of the energy crisis and set the course for a rethinking of the energy-civilization equation. The anti-growth attitudes, however,

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54 | Denton E. Morrison/Dora G. Lodwick: "The Social Impacts of Soft and Hard Energy Systems: The Lovins' Claims as a Social Science Challenge", in: *Annual Review of Energy* 6 (1981), 357-78.

55 | Martin V. Melosi: *Coping with Abundance.Energy and Environment in Industrial America*. Philadelphia: Temple University Press, 1985, 316-19.

56 | Amory Lovins/L. Hunter Lovins/Florentin Krause/Wilfrid Bach: *Least-Cost Energy – Solving the CO_2-Problem.* Andover, MA: Brickhouse Publication Co., 1981.

57 | Florentin Krause/Hartmut Bossel/Karl-Friedrich Müller-Reissmann: *Energiewende. Wachstum und Wohlstand ohne Erdöl und Uran*. Frankfurt/Main: Fischer, 1980.

58 | One of his early publications to this topic is Wilfrid Bach: "Impact of Increasing Atmospheric CO_2 Concentration on Global Climate: Potential Consequences and Corrective Measures", in: *Environment International* 2 (1979), 215-28.

got increasingly marginalised by a new consensus on ready-to-implement technical means for garnering more energy and using it more efficiently. Thus, for example, the Union of Concerned Scientists stated in its report on *Energy Strategies: Toward a Solar Future*:

"The United States can provide a high level of economic prosperity for all its citizens without the wastefully high levels of gross energy use characteristic of conventional government and industry projections. By increasing energy productivity and thereby deriving greater benefit from the energy we use, economic growth can be sustained with little or no growth in overall energy use."[59]

The widespread consensus on the importance of a rise in energy efficiency put two very different groups of actors centre stage at the arena of energy policy. One were engineers serving as efficiency experts whereas the other group were consumers who were supposed to make the right choices about energy-consuming goods and services. In any case, the efficiency paradigm began to shift attention from the hitherto prevalent emphasis on energy production to energy use.[60] In contrast to this emerging and still widely held consensus on energy efficiency as valuable conservation strategy[61],

59 | Henry W. Kendall, Steven J. Nadis, eds.: *Energy Strategies: Toward a Solar Future. A Report of the Union of Concerned Scientists*. Cambridge, MA: Ballinger, 1980, 58.

60 | Despite broad acceptance, however, the efficiency paradigm was also met with scepticism as it was questioned with reference to rebound effects. On rebound effects refer to a growing body of literature, e.g. Sheetal *Gavankar,* Roland *Geyer: The Rebound Effect: State of the Debate and Implications for Energy Efficiency Research*. Bren School of Environmental Science and Management, University of California, Santa Barbara, 2010. http://iee.ucsb.edu/files/pdf/Rebound%20Report%20for%20IEE-UCSB_0.pdf, accessed 28.12.2011.

61 | Energy efficiency is the core element of the EU's Europe 2020 Strategy for smart, sustainable and inclusive growth and of the transition to a resource efficient economy. The European Union has set itself the target for 2020 of saving 20 percent of its primary energy consumption compared to projections. On the EU energy efficiency strategy cf. http://ec.europa.eu/energy/efficiency/index_en.htm, Accessed 28.12.2011.

attitudes on what sources of energy ought to be preferred differed widely.[62] Here, the spectrum of proposed strategies reached from a substantial increase of nuclear power and a rapid return to coal to a strong preference for renewable energies, while suggestions for a proper energy mix with a rising percentage of natural gas stood as a middling position.[63]

The fact that the energy debate focussed ever more on energy transitions since the decade of the oil crisis caused social scientists and historians to revisit the energy-civilization equation. Since the early 1980s, the book market has offered an increasing array of publications dealing in one way or another with past and present energy societies. But while many books published prior to the energy crises of the 1970s had developed the energy-civilization equation in terms of grand stage theories or clear evolutionary progress, post-energy-crises scholars provided more in-depth studies of specific energy systems and sources on the regional or the national level[64], as well as detailed studies of various aspects of energy production and use.[65] For the most part, however, these studies have been concerned with problems of

62 | Langdon Winner: "Energy Regimes and the Ideology of Efficiency", in: George H. Daniels, Mark H. Rose, eds. *Energy and Transport. Historical Perspectives on Policy Issues.* Beverly Hills: Sage, 1982, 261-77.

63 | More detailed is Vaclav Smil: *Energy Transitions. History, Requirements, Prospects*. Santa Barbara, CA: Praeger, 2010.

64 | Cf. among others the survey on the new German speaking electricity history by Bernhard Stier: "Die neue Elektrizitätsgeschichte zwischen kulturhistorischer Erweiterung und kommunikationspolitischer Instrumentalisierung", in: *Vierteljahresschrift für Sozial- und Wirtschaftsgeschichte* 87:4 (2000): 477-87.

65 | So far, only few scholars have aimed at exploring the societal and environmental implications of energy regimes from the perspective of global history. Cf. Vaclav Smil: *Energy in World History*. Boulder, CO: Westview Press, 1994; Smil: *Energy at the Crossroads: Global Perspectives and Uncertainties*. Cambridge, MA: MIT Press, 2003; Smil: *Energy Transitions*; *Rolf Peter Sieferle: Rückblick auf die Natur. Eine Geschichte des Menschen und seiner Umwelt.* München: Luchterhand, 1997; Rolf Peter Sieferle: *Der unterirdische Wald: Energiekrise und Industrielle Revolution*. München: Beck, 1982. For a recent, quite innovative but also debatable suggestion on using power as a synthesizing concept in history cf. Edmund Russell/James Allison/Thomas Finger/John K. Brown/Brian Balogh/W. Bernard Carlson: "The Nature of Power. Synthesizing the History of Technology and Environmental History", in: *Technology and Culture* 52:2 (2011), 246-59.

energy production, transition and provision while the (re)presentation and consumption of energy as well as the cultural perception of energy sources and its use has not yet found the attention it deserves.[66] Approaching energy from the user and mediator perspective, however, is a promising way to get to a more detailed understanding of past and present energy societies and thus to avoid an uncritical replication of the energy-civilization premise that has been and partly still is quite influential in current energy discourses.

Contributing Essays

The aim of this anthology is to contribute to the current scholarly energy debate by shedding light on the political, technological and cultural premises of the high-energy society and its capacities of transitions. In Part One of this collection, the authors deal with cultural representations of energy and how these representations have shaped various high-energy societies of the 20th century. Nina Möllers opens with an investigation of (re)presentations of energy at world's fairs from the late 19th to the late 20th century in the U.S. and Europe. As sites where host countries and cities, exhibitors, and visitors staged their dreams of how the world ought to be and how to get there with the help of new technologies, world's fairs provide excellent windows through which to view the historically changing meanings of electricity. Following designers and visitors through the exhibitions and tracing their communications via written and visual documentation, Nina Möllers shows how electricity was cast in a narrative of abundance that dominated the societal discourse on energy, in the U.S. and in Western Europe for most of the 20th century. Only at the last fair examined – Knoxville, Tennessee, 1982 – was the narrative of abundance modified. Reworking through the preceding oil crises of the 1970s, the fair staged a two-part drama. Scene One told the story of artificial scarcity as imposed by foreign hands, whereas Scene Two demonstrated that American ingenuity mastered the challenge and ensured a return to

66 | At the time still exceptional was David E. Nye: *Consuming Power. A Social History of American Energies*. Cambridge, MA: MIT Press, 1998. For a most recent user-centred energy history see Christopher Jones: "The Carbon-Consuming Home: Residential Markets and Energy Transitions", in: *Enterprise and Society* 12:4 (2011), 790-823.

U.S. energy abundance and national security. In making the rich sources of energy display accessible via careful interpretation, Möllers discloses two related discourses – the promotional discourse of utility companies and consumer goods manufacturers and the societal discourse of energy abundance that was deeply engrained in all world's fairs displays no matter whether they dealt with energy explicitly or not. Both discourses worked together in shaping and communicating a careless energy consumption mentality that spread from the U.S. and became a role model for many societies. Whether they presented electricity as did the fairs in Chicago (1893 and 1933) and New York (1939) or atomic energy that was the big attraction in Brussels (1958) or renewable energies staged in Knoxville (1982), all world's expositions developed and perpetuated an energy narrative promising abundance. By exploring the efforts put into these constructions, Möllers shows that electricity is more than what flows out of wall sockets; it is energetic fluid of 20th and 21st century high-energy societies that must be produced, consumed, and understood on a material and a cultural level.

World's fairs were a prominent but by no means the only place for featuring cultural representations of electricity. At national, regional, and even local levels, utilities became most bustling actors in charging electricity with cultural meanings. Utilities managed to sell electricity only when they were able to convince consumers that it ensured a modern, superior lifestyle in contrast to old-fashioned cooking or heating with coal or gas. The volume's next two contributions take us to Germany and France, exploring how marketers of power companies designed electricity as an everyday life-enchanting icon of modernity.

Sophie Gerber delved deeply into the archives of Berlin's local electricity supplier Bewag, in order to disclose how the company charged electricity with meanings in their efforts to market electricity both before and after World War II. Because electricity is different from most other goods and services as it must be produced at the moment it is consumed, utilities recognized and sought to foster a tight bond between themselves and their customers. That bond was the electricity-consuming appliance. Therefore, utilities closely collaborated with the appliance industry in their marketing strategies. Bewag developed a broad variety of methods and means for advertising electricity. Not just through publications on electricity and appliances that appeared in newspapers, expert journals, customer magazines, and cookbooks and advertising; on buses, subways

and in many other public spaces, but also via public advice centers, training kitchens, installment systems, and stove rental schemes. Utilities and their agents thereby sought to convey the message of progress and modernity through electricity. The narratives deployed throughout Bewag's marketing activities were closely connected to the immediate political context in (West) Germany. During the Weimar Republic, when people experienced hyperinflation and ongoing economic instability, Bewag constructed a narrative of the superiority of electricity through price and safety advantages. In the early years of the Nazi period, electric cooking became a new topic in the marketing efforts. Promoting kitchen ranges promised to increase the efficiency of the utility and at the same time it fit nicely into the Nazi images of 'Aryan' domesticity. With the advent of Germany's post-WWII economic 'miracle', increasing electricity sales became part and parcel of the new social contract based on mass consumption and promised to foster a German nation. Values such as modernity, freedom, leisure and progress provided subtexts within a broad array of electricity advertisements. These positive connotations of electricity, however, were challenged in the decade of the oil crises. Bewag adapted to the new situation as it developed fresh marketing methods in order to charge electricity with green – i.e. ecologically responsible – meanings. Bewag's marketing department developed a broadly accepted narrative on the meaning of electricity as is revealed in its steadily rising power sales, and thus, together with its tightly coupled customers, Bewag decisively contributed to the rapid development of the high-energy society and mentality that has proven to be so hard to reverse.

The third contribution in Part One is also concerned with the marketing strategies of an energy supplier, but this time in France. It covers more than half a century from the end of World War II until the turn to the 21st century. Yves Bouvier has investigated promotional films produced on behalf of the French national electric company, Électricité de France (EDF). He aims to explore how these films worked as cultural representations of electricity and served the business strategy of the public company. The films stage – and therefore shape – the relationship between consumers and energy. Bouvier takes the French sociologists and semioticians Jean Baudrillard and Roland Barthes as points of departure as their approaches to deciphering the world of objects as myths and vehicles of meaning guide his analysis of his material. EDF's films represent energy in a narrative of abundance that developed in various, subsequent steps. In the mid-

1950s, abundance was showcased as a system of electrical objects within the house that EDF had integrated into the modern world via its electricity. In the early 1960s, after consumerism had become more important as the cement of the social order in France, abundance was featured as a rapid accumulation of appliances in households, which were supported by EDF via the installation of new meters. While the appliances in the 1950s stood for concepts of comfort that implied a lessening of laborious housework, the message changed in the 1960s. Now appliances became lifestyle objects and this imbued the narrative of abundance with an unmistakeable flavour of hedonism. The decade of the oil crises severely challenged the hitherto prevalent cultural representation of energy. The French response to the oil crises was twofold: The state extended and accelerated the transition to nuclear power and forbade energy advertising. Thus, EDF had to change the way it communicated with its consumers. It did so by producing films on how to save energy. In these films, not appliances but energy-saving users with their consumption practices figured prominently. With these user projections, EDF was able to adhere to the original narrative of abundance, as the films advised the customers how to maintain an affluent lifestyle by saving energy. In the 1990s, finally, appliances reappeared in the promotional films, now more numerous than ever before. Hedonism had returned in a "hyper-consumer-society," and its architect was EDF. Thus, the cultural representations of energy in EDF's promotional films worked as important, constructed narratives for France's high-energy society; narratives that resonate with the marketing strategies of the German Bewag.

High-energy societies have not only been shaped by cultural representations of energy but also by actual consumption practices. Therefore, Part Two presents three case studies that deal with such energy consumption practices. Of course, energy is not consumed directly but through devices, materials, and processes – as warm water, artificial light, or a pleasantly warm room on a cold day. The authors of the three case studies explore, respectively, how the Bewag as an energy supplier, the German states in the era of the Cold War, and the Austrian social system cast consumption practices and thus contributed to the development of high-energy societies.

Nina Lorkowski probes consumers' warm water usage behind Berlin's bathroom and kitchen doors as a critical factor within Bewag's electricity supply strategy. Driven by the desire to improve the efficiency of power

production by stimulating electricity demand during off-peak-hours, Bewag introduced a marketing and sales program for electric storage water heaters in the 1920s. These had been designed not just to increase the overall electricity demand but to store energy in the form of warm water because they used electric power for heating up water during off-peak hours during the night while their service, warm water, was to be used during the day and therefore without using power in peak-hours. The designers of Bewag's storage water heaters inscribed this usage pattern into the appliances via a time switch and an extra meter. Thus, Bewag controlled the heating-up period via the timer which the users could not manipulate. They could adjust the usage of the appliance to their own needs only by switching it off completely when the water heater was not needed over longer periods of time. This, however, contradicted the strategy of Bewag to use private households as energy storage for balancing load curves. With the economic downturn in the wake of the big crisis from 1929 to 1933, Bewag was confronted with an even larger problem. Because of the drastically decreasing industrial electricity demand, the company now sought to increase its power supply to households not only for balancing load curves but above all to utilize its power plant capacities through any and all possible means. Preventing users from switching off their water heaters and extending heating-up times during the day appeared as an appropriate strategy to increase households' electricity demand. For generating a more steady need for warm water, Bewag rented out water heaters with two or three outlets, one of which supplied the kitchen. The restrictions of charging time to night hours were abandoned. The consumption practice that Bewag had sought to inscribe in the appliance design, however, was adopted by consumers only partly, as they stuck to old hygiene and bathing customs with a weekly bathing day instead of showering daily. But once the appliance had found its way into the household, it at least opened the possibility for an increased residential energy use. This possibility began to materialize in the 1950s when the state's promotion of energy-consuming household appliances as part of the implementation strategy of the West German social market economy proved to be a tremendous success. Within this framework, however, the meaning of consumption and energy use changed according to consumers' growing expectations about convenience and hygiene. In this context, no longer could the utility company prescribe to the consumer which appliances should be used and how and when to guarantee a more balanced capacity utilization. Instead, surging residential

energy demand now became a reason to generally extend power plant capacities. The case study by Lorkowski is revealing in two respects. It clearly shows how utilities conceived of households as elements of their production strategy and how they used appliances to shape consumer practices. But Lorkowski also points us to the actual consumers who rewrote the inscribed user scenario by using the appliances subversively. Thus, she makes us aware that imposed technical means for manipulating energy use are rather questionable strategies because energy consumption practices are the outcome of societal contracts and cultural traditions and not an unchangeably materialized script within technologies.

Not just appliances but also the organization of time has been mobilized to manipulate energy consumption practices. In the second case study, Matthias Mutz documents the introduction of Daylight Saving Time (DST) in order to understand its meaning within and beyond the energy discourse for both German states in the energy crises of the 1970s. The debate on DST began immediately in the wake of the first oil crisis in West Germany. Thus, DST was cast in the frame of an emergency measure, bearing resemblance to earlier DST introductions as wartime actions in the First and the Second World War. But the West German debates after the first oil shock (that had not hit East Germany because of oil contracts with the USSR) did not result in DST-introduction. In contrast to most European states that did advance their clocks for an hour in the mid-1970s, the political actors in Bonn and, with a time lag, the political players in East Berlin opted against changing clocks. Both governments used similar arguments as justifications. DST would provide only marginal energy savings, but it could, if not introduced in both German states at the same time, erect a time border and thus endanger the delicate balance in inter-German relations. The introduction of DST by European neighbour states was said to be a lifestyle choice and thus irrelevant for the two German states. Only after the second oil crisis did German attitudes change, and in October 1979, first in East Berlin and 13 days later in Bonn, the Germans decided to implement DST the following year. Mutz carefully outlines how energy policy contributed to this decision. In West Germany, DST increased the acceptance of energy saving that was now cast more in terms of energy efficiency and allowed everybody to participate in the saving 'hype' without changing individual consumption practices. In East Germany, DST worked as a substitute for an earnest energy policy with more effective energy saving measures. Energy consumption practices in private households

remained untouched by the East German state, as it stuck to a constant low price for a kilowatt hour of electricity of 8 (nominal) Pfennig since 1946. In the end, both German states introduced DST not least because of its positive 'side effects' of leisure and recreation. Thus, DST contributed to the transformation of the energy discourse from a narrative of crisis and scarcity to a narrative of abundance and well-being, respectively. In this way, DST helped to maintain established energy consumption practices in the decades after the "golden years," as Hobsbawm described the 1950s and 1960s.

The last case study of Part Two takes us to contemporary Austria. Karl-Michael Brunner, Anja Christanell and Markus Spitzer investigate energy consumption practices in Austrian low-income households. While most studies on differences of energy consumption conceive of these inequalities in terms of their global dimension, this case study points to the fact that even within industrialised countries, residential energy consumption is far from being equally distributed throughout society. Analysing these differences, however, is crucial for governing the way toward a 'low-carbon-society,' as different lifestyles have different impacts on the environment while at the same time they vary in their vulnerability to climate change. The latter will have especially discriminative effects on low-income households as they have less means to make provisions for negative climate effects. Therefore, by exploring the phenomenon of fuel-poverty in the Austrian capital, Vienna, the authors shed light on the social dimension of energy consumption practices in order to address problems of environmental justice. As they look at housing and living conditions as well as heating and lighting practices, the contributors reveal how social inequalities become manifest in energy consumption practices. They show that fuel-poor households develop a specific energy culture via sacrifices in comfort and living standard. At the same time, low-income households encounter major difficulties in tapping their households' full efficiency potential due to factors beyond their reach, such as inefficient construction features of buildings, heating technologies, and larger, less efficient pre-installed household appliances in low-priced flats. Although fuel-poor households are forced to pioneer in energy saving strategies, they are disadvantaged in reaping the benefits. Therefore, the authors conclude, governing the transition to a socially just 'low-carbon society' requires societal interventions against fuel poverty.

Part Three of this volume is concerned with cultural perceptions of and national discourses on energy resources. As the last and the ongoing centuries were and are marked by continual energy transitions due to various short-term emergency and longer-term structural forces such as imbalances in the world economy, wartime scarcity and global ecological policy, to name but a few, energy resources became a prominent subject of public debates. Three case studies trace these debates in Sweden, Norway and West Siberia in order to reveal what determined perceptions of both energy resources and the feasibility of energy transitions. The final chapter investigates the relationship between patterns of energy transitions and economic growth in Europe during the last two centuries.

Helena Ekerholm reconstructs the story of wood gas in Sweden, which was pursued as a national means of transitioning from petrol to domestic fuel alternatives between 1930 and 1945. But the planned fuel transition failed. Wood gas provides an interesting case in several respects: first, it is a renewable fuel; second, it played a partial role in the emerging automobile culture; third, it promised to boost the struggling forestry industry; and finally, wood gas was included in wartime emergency plans. Wood gasification technology was a 19th century British invention that attracted interest as an alternative means of automobile propulsion in several countries across the globe early in the automobile era. Sweden began to consider wood gas as it looked for ways out of the crisis in the nationally important forestry industry in the early 1930s. By 1932, the Swedish government had established a wood gasifier loan fund intended to push the new technology, which experienced a fiasco after a short-lived boom. The gasifiers had not met user expectations for manifold reasons, which Ekerholm explores in detail. The loan failure resulted in new evaluations that established a more specific user profile. But not until the outbreak of World War II did wood gas receive a second chance, this time as a wartime surrogate. Optimists, however, expected an enduring breakthrough for wood gas and hoped that it would find its place in peacetime economy. But this did not come to pass for several reasons such as hazards connected to wood gas use and troublesome maintenance problems. These and other reasons contributed to the perception that wood gas usage was contradictory to the highly esteemed ideals of a modern automotive culture. Because wood gas could not overcome its connotations of wartime surrogate and outdated fuel, it did not endure. Thus, Ekerholm's story is a case study on a failed transition from fossil to renewable fuels.

The next case study leads the readers to West Siberia and covers the four decades from the 1970s to the present. In the decade when the oil crises hit the Western bloc, the Soviet state rapidly increased the exploitation of West Siberia's oil deposits. Since that time, the Soviet Union and then the Russian state has become increasingly dependent on the oil resources of this region, while in Western Europe efforts were taken to decrease carbon emissions from hydrocarbons by way of a transition to lower-carbon non-renewable and renewable sources of energy. By contrast, the rapid exploitation of the oil deposits in West Siberia not only prevented the Soviet and the Russian governments, respectively, from pondering an energy transition toward a more sustainable path, but it also caused tremendous environmental problems in West Siberia. Valentina Roxo analyses the public debates on West Siberian oil production in order to understand how, despite the coincidence of the West Siberian oil boom with the international boost of environmentalism, the latter did not have any impact on the former. Roxo shows that until the mid-1980s environmental data had been kept secret in the USSR and no public discussion could emerge. Only as a result of the glasnost reforms and especially following the Chernobyl catastrophe did environmental institutions spring up, decrees were issued, and ecological problems began to be discussed openly. But the most critical problems in the oil sector were left out of the public debate. Instead, in the wake of the Chernobyl disaster, oil was perceived as a secure source to meet the energy needs. This positive attitude toward oil took the form of a socialist version of a Promethean discourse, as the conquest of nature for the extraction of oil was celebrated as a human achievement. The depletion of natural resources and environmental destruction from oil extraction was denied by Soviet leaders. The finiteness of resources was to be overcome by science and technology and communism would lead to a state of abundance. Also, the narrative of the development of the West Siberian region from a backward place into a modern industrial landscape was cast as Promethean discourse. That living conditions of the indigenous West Siberian people had changed completely was glorified as tremendous progress. Only when the Soviet Union collapsed, did a more critical discourse begin to emerge. The lot of the indigenous population, conflicts between them and the oil industry, the poor state of the new cities in the region, and the environmentally disastrous practice of gas flaring – all these problems now came to the fore. But after the turn of the new millennia, the just-emerging environmental discourse began to be superseded again, this time by the

debates on dangerous symptoms of the so-called Dutch disease. Now economic debate drew all attention, and the ecological tragedy of Samotlar, which the World Bank had declared an ecological disaster zone in 2000, disappeared into oblivion, at least in the Russian media. Roxo ends her discourse analysis with the conclusion that the vital importance of the oil wealth for the national economy led to a dramatic ecological blindness of both state energy policy and the energy consuming Russian people.

Contradictory perceptions of energy resources were by no means confined to fossil fuels. The next contribution introduces readers to ambivalent public attitudes toward bioenergy in today's Norway and Sweden. These ambivalent opinions exist at various levels. The case study focuses on views that have been ascribed to imagined publics by policy makers, experts and the bioenergy industry, as these protagonists of bioenergy interpret what they assume are public perceptions of bioenergy. According to insights from Science and Technology Studies, the success of controversial innovations hinges upon public engagement in science and technology. Thus, the protagonists of bioenergy innovations have to imagine their publics and engage them in their projects. Tomas Skjølsvold probes how the bioenergy players imagine their publics in Norway and in Sweden and how these imagined collectives determine the strategies of public engagement. Bioenergy occupies very different places in the respective energy regimes of Norway and Sweden. In Norway, where it gained political attention as a potential replacement for space heating based on hydroelectricity, bioenergy is a niche technology. In contrast, Sweden has a more diverse energy regime based on three nearly equally important energy sources: fossil fuels, hydroelectricity and nuclear power. Both to reduce their dependence on fossil fuels and nuclear power and to mitigate climate change, the Swedes developed an early interest in bioenergy and advanced its contribution to total energy supply to one third. Therefore, in Sweden, bioenergy is at the core of energy policy, and it has become the largest energy-producing technology within the Swedish energy regime. Skjølsvold takes this significant difference between the two countries as point of departure to analyse how each nation's bioenergy establishment construe its imagined publics. He demonstrates how this difference remarkably influenced the ideas about bioenergy's respective publics. These ideas have been much more unfavourable in Norway than in Sweden. Norwegians are thought to be opposed to the construction of new bioenergy facilities because of landscape alterations, pollution, odors

and increased traffic. The Swedes, however, are construed as passive but positively-minded consumers who would not care about bioenergy production, as they take it for granted. To be sure, the ideas about the public have many more facets in both countries, as Skjølsvold clearly shows. But the significant difference between imagined more sceptical Norwegian and more affirmative Swedish publics remains visible even in the many-facetted picture. Accordingly, the bioenergy players draw different conclusions for their subsequent strategies to engage their publics. While the Swedes seek to enlighten the imagined passive consumers and to develop an open, two-way dialogue, the Norwegians opt for meetings with perceived stakeholders prior to the construction of new facilities in order to prevent protests. Through his comparative analysis, Skjølsvold shows how even imagined, culturally-constructed agents play important roles in shaping energy transitions.

The final contribution in this anthology is concerned with the connection between energy and long-term economic growth in Europe. In her first part, Silvana Bartoletto analyses the debate whether there was an energy crisis in the 18th century that caused the transition from traditional to modern energy sources in the 19th century. Although the question has remained unsettled so far, there is no doubt about the multiple ways and chronological differences the energy transition took across Europe. The passage from the old to the modern energy system occurred rapidly in countries like England and Wales and to some degree in the Netherlands, while in Sweden, Italy and Spain, the transition followed only in the 20th century. In her second part, Bartoletto outlines the results of the transition as they are manifested in the structure of the fossil fuel system and the distribution of energy consumption by sector. She notes the gradual turning away from oil after the crises in the 1970s and gives evidence for industry, transport and the residential sectors as the main energy consumers in Europe in 2007. Changes in the intra- and inter-sectorial distribution of energy consumption cause important variations of energy demand due to structurally different energy intensities. Bartoletto uses the long-term development of energy intensity, i.e. the energy required to produce one unit of output, as an indicator to gauge the relationship between energy, economy and technological change. After a detailed discussion of a broad array of determining factors for energy intensities and their changes, Bartoletto concludes that this indicator alone is not sufficient to fully understand the relation between energy, economy and

technological change. Therefore, she introduces energy productivity as the reciprocal of energy intensity, i.e. the income produced per unit of energy. This allows her to draw a more detailed picture with the help of a decomposition analysis of per capita GDP, which enables her to determine the contribution of the growth rate of energy consumption per capita and the growth rate of energy productivity to the growth rate of per capita GDP. Her data reveal four distinct periods, each characterised by a specific energy-growth relationship. The first period, from 1830 to the end of the 19th century, shows a reduction of energy productivity. In the next phase, from the beginning of the 20th century until World War II, the productivity of energy became more important for economic growth, especially because of improvements in the efficiency of techniques of energy utilization. From the end of the Second World War until the energy crises of the 1970s, readily available cheap energy was more important for economic growth than any gains in thermodynamic efficiency of the techniques in question. After the decade of the oil crises, finally, improvements in energy efficiency became more and more important in economic growth. As Bartoletto reveals these long-term trends in the relation between energy, economy and technological change for the European context, she raises our awareness of the long-running nature and complexities of energy transitions. Thus, we may better understand what the current – and increasingly urgent – energy transition to a more sustainable regime will entail.

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